clinical accepted plans for both automated TPS was drastically reduced to less than ten minutes.
For the two stereotactic sites evaluated, target coverage and OARs doses differences were not clinically relevant between Auto-Planning and manually optimized plans.
The encouraging results of automatic planning shows that highly consistent treatment plans for complex cases can be achieved with an automated planning process.

SP-0312
Automated treatment plan generation - the Milan experience

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A knowledge based planning process, named RapidPlan, has been recently implemented into the Varian Eclipse treatment planning system. The goal of the engine is to generate patient tailored and personalized objectives to input in the optimization process for IMRT or VMAT inverse planning. Data from previously generated high quality plans are used to estimate DVH ranges where the specific DVH of a structure will most likely land according to the prior plans knowledge. Estimate-based optimisation objectives are hence generated. A complete pre-clinical preparation have been established before the clinical implementation of RapidPlan and the configured specific models. The anatomical sites and pathologies chosen for the first models generation in Milan were Head and Neck, and Breast. For the first site the choice was driven by the complexity of the planning phase due to the anatomy and critical structures; the breast was chosen since, beside of its planning complexity, almost one third of our patient population presents breast cancer. For each of the two chosen sites the process of the model generation included different phases. Initially a set of about 100 patients per site, having quite spread anatomical characteristics (as, for example, the breast size) while excluding extreme anatomies, was selected. The selected plans were all clinical plans of high quality, for VMAT (RapidArc) delivery. Those plans were used to train the model for the extraction of the parameters, based on prinicipal component analysis methods and regression models, needed to estimate the DVH for any new patient. The training results were analysed to evaluate possible outliers and their eventual exclusion from the model. Finally the validation process was followed on another group of patients to assess the model reliability and usability. From this last phase improvements in the plan quality when using RapidPlan was assessed. Once the two models were evaluated, a number of head and neck and breast cases were selected for the pre-clinical trial. The planners used to plan without RapidPlan were asked to produce plans using the knowledge based planning models. Two kind of evaluations were felt interesting: on one side the plan quality, for which the same cases were asked to be planned without RapidPlan by the same planner, and on the other side the time required to obtain such plans. The results were very promising, both on the plan quality, and especially on planning time. We are ready to move to the clinical daily use of the automated treatment plan generation.

SP-0313
Fully automated treatment plan generation using Erasmus-iCycle - the Rotterdam experience

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Aim: Treatment plan generation in radiotherapy is commonly a trial-and-error procedure in which a dosimetrist tries to steer the treatment planning system (TPS) towards an acceptable patient dose distribution. For a single patient, this process may take up to several days of workload. The quality of the final treatment plan is dependent on the skills and experience of the dosimetrist, and on allotted time. In addition, for the treating physician it is extremely difficult to assess whether the generated plan is indeed optimal considering the unique anatomy of the individual patient. At Erasmus MC, systems for fully automated plan generation have been developed to obtain plans of consistent high quality, with a minimum of workload. This presentation will focus on their clinical implementation and applications.

Materials and methods: An IMRT or VMAT plan is generated fully automatically (i.e., without human interface) by the clinical TPS (Monaco, Elekta AB), based on a ***patient-specific*** template. The patient-specific template is automatically extracted from a plan generated with Erasmus-iCycle, our in-house developed pre-optimizer for lexicographic multi-criterial plan generation (Med Phys. 2012; 39: 951-963). For individual patients of a treatment site (e.g., prostate), automatic plan generation in Erasmus-iCycle is based on a ***fixed*** 'wishlist' with hard constraints and treatment objectives with assigned priorities. The higher the priority of an objective, the higher the chance that the planning aim will be achieved, or even superseded. All plans generated with Erasmus-iCycle are Pareto optimal. In case of IMRT, the system can be used for integrated beam profile optimization and (non-coplanar) beam angle selection. ***Site-specific wishlists*** are a priori generated in an iterative procedure with updates of the wishlist in every iteration step, based on physicians' feedback on the quality of plans generated with the current wishlist version. Also for patients treated at a Cyberknife, either with the variable aperture collimator (Iris) or MLC, the clinical TPS (Multiplan, Accuray Inc.) can be used to automatically generate a deliverable plan, based on a pre-optimization with Erasmus-iCycle.

Results: Currently, automatic treatment planning is clinically used for more than 30% of patients that are treated in our department with curative intent. It is routinely applied for prostate, head and neck, lung and cervical cancer patients treated at a linac. In a prospective clinical study for head and neck cancer patients, treating radiation oncologists selected the Erasmus-iCycle/Monaco plan in 97% of cases rather than the plan generated with Monaco by trial-and-error (IJROBP 2013; 85: 866-72). For a group of 41 lung cancer patients, clinically acceptable VMAT plans could be generated fully automatically in 85% of cases; in all those cases plan quality was superior compared to manually generated Monaco plans, due to a better PTV coverage, dose conformality, and/or sparing of lungs, heart and oesophagus. For plans that were initially not clinically acceptable, it took a dosimetrist little hands-on time (<10 minutes) to modify them to a clinically acceptable plan. In 44 dual-arc VMAT Erasmus-iCycle/Monaco plans for cervical cancer treatment small bowel V45Gy was reduced by on average 20% ($p<0.001$) when compared to the plans that were manually generated by an expert Monaco user, spending 3 hours on average. Differences in bladder, rectal and sigmoid doses were insignificant. For 30 prostate cancer patients, differences between Erasmus-iCycle/Monaco VMAT plans and VMAT plans manually generated by an expert planner with up to 4 hours planning hands-on time, were statistically insignificant (IJROBP 2014; 88(5): 1175-9). Attempts to use acceptable, automatically generated plans as a starting point for manual generation of further improved plans have been unsuccessful. For prostate SBRT, clinically deliverable Cyberknife plans that were automatically generated with Erasmus-iCycle/Multiplan showed a better rectum sparing and a reduced low-medium dose bath compared to automatically generated VMAT plans with the same CTV-PTV margin.

Conclusion: In our department, automatic plan generation based on Erasmus-iCycle is currently widely used, showing a consistent high plan quality and a vast reduction in planning workload. Extension to new target sites (breast, liver, lymphoma, spine, vestibular schwannoma) is being investigated. In addition, the use of automated planning for intensity modulated proton therapy is being explored, making objective plan comparison with other modalities possible.